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LETTER

Comment on "Non-vacuum conformally flat space-times: dark energy"

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Abstract Ibohal, Ishwarchandra and Singh (Ibohal et al., Astrophys. Space Sci. 335, 581, 2011) proposed a class of exact, non-vacuum and conformally flat solutions of Einstein's equations whose stress tensor T_{ab} has negative pressure. We show that T_{ab} corresponds to an anisotropic fluid and the equation of state parameter seems not to be $\omega = -1/2$. We consider the authors' constant cannot be the mass of a test particle but is related to a Rindler acceleration of a spherical distribution of uniformly accelerating observers.

Keywords Negative pressure · Stress tensor · Dark energy · Rindler acceleration · Anisotropic fluid

In their paper (Ibohal et al. 2011), Ibohal, Ishwarchandra and Yugindro Singh (IIS) analyzed in detail exact solutions (stationary and non-stationary) of Einstein's equations by especially using the case $n = 2$ in the Wang-Wu mass function expression. We write down the IIS line element of a general metric in Eddington-Finkelstein coordinates (u, r, θ, ϕ)

$$ds^2 = \left(1 - \frac{2M(u,r)}{r}\right)du^2 + 2du dr - r^2 d\Omega^2, \tag{1}$$

where $M(u,r)$ is the mass function and u is the retarded time coordinate. Using the general form (2.2) of the energy-momentum tensor, they identified the parameters μ, ρ and p as (Ibohal et al. 2011)

$$\mu = -\frac{2}{Kr^2}\frac{\partial M(u,r)}{\partial u}, \qquad \rho = \frac{2}{Kr^2}\frac{\partial M(u,r)}{\partial r}, \qquad p = -\frac{2}{Kr}\frac{\partial^2 M(u,r)}{\partial r^2} \tag{2}$$

with $K = 8\pi G/c^4$. One seems to be a typos in the above expression of the pressure p of the fluid in Ibohal et al. (2011), with factor 2 instead of 1. That was rectified in Eq. (2.9) where $p = -\rho/2$.

It is worth to note that the previous expressions for μ, ρ and p in (2) do not depend on the Newton's constant G. For example, the energy density ρ can be written as (fundamental constants included)

$$\rho = \frac{2c^4}{8\pi G r^2}\frac{G}{c^2}\frac{\partial M(u,r)}{\partial r} = \frac{c^2}{4\pi r^2}\frac{\partial M(u,r)}{\partial r}. \tag{3}$$

A similar G-independent expression has been obtained in Culetu (2012a) (Eq. (4.10)) for the heat flux in a time dependent Schwarzschild-de Sitter geometry.

Let us now proceed to the particular case chosen by IIS for the mass function, namely

$$M(u,r) = mr^2. \tag{4}$$

Now the metric (1) becomes

$$ds^2 = (1 - 2mr)du^2 + 2du dr - r^2 d\Omega^2, \tag{5}$$

where $d\Omega^2$ is the metric on the unit 2-sphere. The Authors of Ibohal et al. (2011) take the constant m as the mass of a test particle present in the spacetime. In our view, the gravitational field generated by a test particle is negligible and its behavior is determined by other (bigger) particle(s) around it. Therefore, the mass m cannot be present in the metric (it

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